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42-04	3,19,09	6776 DIN

RICHARDSON SMITH GARDNER
& ASSOCIATES
ENGINEERING & GEOLOGICAL
SERVICES

RECEIVED
MAR 18 2009
SOLID WASTE SECTION

March 18, 2009

Mr. Zinith Barbee
Project Manager
Solid Waste Section – NCDENR
1646 Mail Service Center,
Raleigh, NC 27699-1646

Re: **Revised Corrective Action Plan**
Halifax County C&D Landfill, Area 1
Permit 42-04

Dear Mr. Barbee,

On behalf of Halifax County Landfill, Richardson Smith Gardner & Associates, Inc (RSG) has prepared this response to the conditions of approval issued on Febrruary 16, 2008 (**copy attached**). Please find each comment in *italics* and the associated response below.

Comment No. 1

Update Table 4 to refelct current state groudwater quality standards for all the listed constituents. Include the standard for bis (2-ethylhexyl) phthalate and alpha BHC. Although bis (2-ethylhexyl) phthalate is not reported as a costituent of concen now, it is reportedly detected above the state standard without specification of that standard.

Response No. 1

Table 4 has been updated to reflect the cuurent groundwater quality standards. Currently there are no groundwater quality standards for bis(2ethyl-hexyl) phthalate or Alpha BHC, however, the standards state that any detection of a constituent above the PQL where no standard is set, comprises an exceedance of the standards. Additionally, Alpha BHC has a groundwater protection standard of 0.006 ppb, which is below the detected concentration. A revised **Table 4** is attached for your review.

Comment No. 2

In Section 2.7 include toluene on the list of " exceedences", since elsewhere in the CAP it is identified as exceeding the state standard.

Response No. 2

Section 2.7 of the text of the Corrective Action Plan (CAP) has been updated to reflect toluene as a constituent whose concentration has exceeded the groundwater standards.

Comment No. 3

Present a plan to address deterioration of the groudwater monitoring wells mentioned at the end of Section 2.1. Pursuant to Regulation 15A NCAC 2C.0108(C)(12), condition of wells should not "preclude accurate chemcial analysis of any fluid samples collected."

Response No. 3

Halifax County plans to redevelop the monitoring wells at the site by utilizing a surge block to surge the wells and loosen and remove silt from the sand pack and well bottom. The silt will be removed from the well via pumping of the well. Turbidity measurements will be collected during the pumping process to evaluate the success of the redevelopment. The Surge and Pump technique is a standard method of well redevelopment and has been used successfully at many sites. The well redevelopment will be carried out prior to the Fall 2009 groundwater monitoring event. Data from the redevelopment will be submitted with the Fall 2009 groundwater monitoirng report.

Comment No. 4

Submit information for financial assurance. Understood is that it is referenced in Attachment I of the Permit to Operate (PTO) submitted for the site. However, in neither the PTO, previously submitted permit modification application, or current finanical instument is there a " detailed written estimate, in current dollars" pursuant to Regulations 15A NCAC 13B .1628(a)(4) and 1628(d). The CAP is required pursuant to 15A NCAC 13B .0547(4) (C), effective July 1, 2008.

Response No. 4

Section 8.0 of the revised CAP text outlines specific financial data regarding the implementation of the proposed corrective actions. This includes both first year costs and estimated costs for a 30-year timeframe. A copy of the revised text is attached for your review.

Should you have any questions or require clarification, please contact us at your earliest convenience at (919) 828-0577 or by email listed below

Sincerely,
Richardson Smith Gardner & Associates, Inc.

Joan A. Smyth

Joan Smyth
Senior Hydrogeologist
joan@rsgengineers.com

Attachments

Cc: Mr. Frank Ralph, Public Utilities of Halifax County
File

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

February 16, 2009

Mr. Frank Ralph
Director of Public Utilities.
P. O. Box 70
Halifax, North Carolina 27839

Subject: Revised Corrective Action Plan
Halifax County C & D Landfill, Area 1
Permit 42-04
Doc ID 6655

Dear Mr. Ralph:

The Solid Waste Section (SWS) reviewed the Corrective Action Plan (CAP) for the Halifax County Landfill, Area 1. The following revisions are necessary at this time. One, update Table 4 to reflect current state groundwater quality standards for all the listed constituents. Include the standard for bis (2-ethylhexyl) phthalate and alpha BHC. Although bis (2-ethylhexyl) phthalate is not reported as a constituent of concern now, it is reportedly detected above the state standard without specification of that standard. Two, in Section 2.7 include toluene on the list of "exceedences", since elsewhere in the CAP it is identified as exceeding the state standard. Three, present a plan to address deterioration of the groundwater monitoring wells mentioned at the end of Section 2.1. Pursuant to Regulation 15A NCAC 2C .0108(c)(12), condition of wells should not "preclude accurate chemical analysis of any fluid samples collected." Finally, submit information for financial assurance. Understood is that it is referenced in Attachment I of the Permit to Operate (PTO) submitted for the site. However, in neither the PTO, previously submitted permit modification application, or current financial instrument is there a "detailed written estimate, in current dollars" pursuant to Regulations 15A NCAC 13B .1628(a)(4) and 1628(d). The CAP is required pursuant to 15A NCAC 13B .0547(4)(c), effective July 1, 2008.

The revised CAP should be submitted within 30 days of the receipt of this letter. If you have questions, please contact me at 919-508-8401 or at zinith.barbee@ncmail.net.

Sincerely,

Zinith Barbee

Zinith Barbee
Project Manager
Solid Waste Section

cc: Ed Mussler	Solid Waste Section
Mark Poindexter	Field Operations Supervisor
Donald Herndon	SWS CO
Joan Smyth, L.G.	RSG & Asso., Inc.
Central File	

Table 4
August 2007 Detected Constituents
Halifax County Landfill
Aurelian Springs, North Carolina

08/09/07

Constituent	PQL	2L Standard	GWP Standard	MW-1	MW-2a	MW-2ad	MW-3a	MW-3d	MW-6d	MW-7d	MW-15r	MW-16a	MW-17	MW-18s	MW-18d	SW-1	SW-2	SW-3
Antimony	6	---	1.4	0.1 J	0.1 J	ND	ND	ND	ND	ND	0.1 J	ND	ND	ND	ND	ND	ND	ND
Arsenic	10	50	---	ND	1.7 J	0.9 J	1.4 J	ND	ND	ND	ND	ND	0.6 J	1.4 J	ND	1.6 J	1.9 J	1.6 J
Barium	100	2000	---	35.1 J	93.3 J	**108**	33.7 J	60.4 J	**547**	43.1 J	89.6 J	91.9 J	**110**	**139**	77.5 J	48 J	82.9 J	45 J
Beryllium	1	---	4	0.1 J	0.4 J	ND	0.1 J	0.3 J	0.4 J	0.2 J	0.2 J	0.5 J	**2**	0.9 J	ND	ND	ND	0.8 J
Cadmium	1	1.75	---	0.1 J	0.1 J	0.4 J	0.6 J	0.1 J	0.2 J	0.1 J	0.3 J	0.5 J	0.2 J	0.2 J	ND	0.2 J	0.6 J	0.9 J
Chromium, total	10	50	---	0.4 J	4.1 J	6.6 J	ND	0.4 J	ND	1.4 J	0.6 J	ND	1.7 J	2.1 J	ND	0.7 J	ND	ND
Cobalt	10	---	70	0.6 J	5.9 J	4.5 J	2.7 J	ND	4.4 J	ND	0.5 J	ND	2.5 J	5.3 J	ND	1.8 J	1.3 J	2.5 J
Copper	10	1000	---	1.2 J	1.1 J	0.9 J	0.5 J	0.5 J	0.8 J	1.1 J	1.5 J	0.9 J	3.6 J	3.6 J	ND	1.3 J	0.6 J	1 J
Lead	10	15	---	0.2 J	0.8 J	0.2 J	0.2 J	0.3 J	0.3 J	1 J	0.1 J	0.3 J	7.5 J	3.9 J	0.4 J	2.5 J	0.1 J	0.1 J
Mercury	0.2	1.05	---	ND	ND	0.06 J	0.04 J	0.15 J	0.08 J	ND	**6.65**	**0.44**	ND	ND	ND	ND	ND	ND
Nickel	50	100	---		2.5 J	5.7 J	ND	0.7 J	2.3 J	1.1 J	ND	ND	2.7 J	3 J	0.9 J	ND	1.2 J	3.3 J
Selenium	10	50	---	0.8 J	ND	ND	ND	ND	0.8 J	ND	ND	ND	ND	0.5 J	ND	ND	2.5 J	7.5 J
Thallium	5	---	0.28	0.1 J	ND	ND	ND	ND	ND	ND	0.2 J	ND	0.1 J	0.2 J	ND	ND	ND	ND
Tin	100	---	---	ND	0.9 J	0.8 J	0.6 J	0.6 J	1 J	0.7 J	1.3 J	0.6 J	ND	ND	ND	ND	ND	ND
Vanadium	25	---	3.5	ND	2.9 J	ND	ND	ND	0.7 J	ND	ND	ND	9.6 J	15.3 J	2 J	2.9 J	ND	3 J
Zinc	10	1050	---	3.1 J	4.6 J	5.8 J	2.7 J	5.5 J	ND	8.9 J	3.6 J	6.9 J	**36**	**44**	5.3 J	ND	2.9 J	ND
1,1,1-Trichloroethane	1	200	---	ND	ND	ND	ND	ND	ND	ND	0.2 J	0.3 J	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	5	70	---	ND	4.4 J	**36.8**	**5.6**	4.3 J	1 J	ND	**10.3**	**14.3**	3.10 J	1.2 J	1.5 J	ND	ND	ND
1,1-Dichloroethene	5	7	---	ND	0.2 J	0.4 J	0.3 J	0.3 J	ND	ND	ND	0.4 J	0.2 J	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	5	24	---	ND	ND	ND	ND	ND	0.3 J	ND	ND	0.9 J	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	1	0.38	---	ND	0.4 J	ND	ND	ND	0.2 J	ND	0.6 J	0.3 J	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	1	0.51	---	ND	ND	0.2 J	0.3 J	ND	ND	ND	ND	0.6 J	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	3	1.4	---	ND	ND	0.7 J	0.4 J	ND	1.9 J	ND	**10.2**	1.4 J	ND	ND	ND	ND	ND	ND
2-Butanone	100	4200	---	1.8 J	2.1 J	1.7 J	2.2 J	1 J	1.8 J	1.9 J	1.8 J	2.1 J	ND	1.4 J	ND	1.9 J	3.8 J	1.7 J
Acetone	100	700	---	ND	1.4 J	ND	1.4 J	ND	1.3 J	1.3 J	1.5 J	2.1 J	ND	9.10 J	ND	ND	2.2 J	2.6 J
Benzene	1	1	---	ND	ND	0.9 J	0.8 J	0.2 J	**2.1**	ND	0.3 J	**2.9**	ND	ND	ND	ND	ND	ND
Bis-(2-Ethylhexyl) Phthalate	15	---	---	ND	ND	ND	ND	ND	**15.1**	ND	**31**	**11.1**	ND	ND	ND	ND	ND	ND
cis-1,2-Dichlorethene	5	70	---	ND	2.7 J	**22.9**	**8.1**	1.2 J	ND	ND	**7.8**	**40.5**	1.4 J	0.2 J	0.8 J	ND	ND	ND
Chlorobenzene	3	50	---	ND	0.2 J	1.1 J	0.6 J	ND	**9.7**	ND	0.2 J	1.1 J	ND	ND	ND	ND	ND	ND
Chloroethane		2800	---	ND	2.5 J	ND	0.7 J	ND	0.6 J	ND	0.3 J	0.9 J	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	5	1400	---	ND	0.3 J	0.3 J	0.2 J	1.8 J	0.2 J	ND	0.4 J	4.7 J	ND	ND	ND	ND	ND	ND
Methylene chloride	5	4.6	---	ND	ND	0.2 J	ND	0.7 J	0.2 J	ND	**6.5**	**22.5**	0.2 J	ND	ND	ND	ND	ND
Tetrachloroethene	3	0.7	---	ND	ND	ND	0.4 J	1.9 J	ND	ND	**3.3**	**26.6**	**1.1**	ND	ND	ND	ND	ND
Trichloroethene	3	2.8	---	ND	0.6 J	**5.4**	2 J	1.9 J	ND	ND	**4.4**	**20.8**	**1.8**	ND	0.3 J	ND	ND	ND
Toluene	1	1000	---	0.4 J	0.4 J	0.5 J	0.5 J	0.6 J	0.5 J	0.4 J	0.4 J	0.6 J	ND	0.3 J	ND	0.4 J	0.3 J	0.3 J
Trans-1,2,-Dichloroethene	5	100	---	ND	ND	0.3 J	ND	ND	ND	ND	ND	0.4 J	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	1	2100	---	ND	ND	ND	ND	ND	ND	ND	0.3 J	**1.3**	0.3 J	ND	ND	ND	ND	ND
Vinyl Chloride	5	0.015	---	ND	1.8 J	**5.8**	**4.7**	ND	**1.4**	ND	ND	0.8 J	ND	0.7 J	ND	ND	ND	ND
Xylenes	4	530	---	ND	ND	ND	ND	ND	ND	ND	2.2 J	2.3 J	ND	ND	ND	ND	ND	ND
Heptachlor	0.05	0.0078	---	ND	ND	ND	ND	ND	ND	ND	**0.1**	ND	ND	ND	ND	ND	ND	ND
Alpha-BHC	0.05	---	0.006	ND	ND	ND	ND	ND	ND	ND	**0.292**	ND	ND	ND	ND	ND	ND	ND

ND - Not detected at or above PQL
Shading - Levels above 2L standard or no 2L standard
Bold Letters - Constituent detected above PQL
J - Detected constituents below PQL limit
GWP - Groundwater Protection

All PQLs, 2L Standards and Results are in ug/l.

Corrective Action Plan

Halifax County Landfill
Aurelian Springs, North Carolina

NC Solid Waste Permit No. 42-04

Prepared For:

Halifax County Public Works
P.O. Box 70
Halifax, North Carolina 27839

Prepared By:

RICHARDSON SMITH GARDNER
& ASSOCIATES
ENGINEERING & GEOLOGICAL
SERVICES

Original Submittal: June 2008

Revised: March 2009

Corrective Action Plan

Halifax County Landfill
Halifax County, North Carolina

Prepared for:
Halifax County Department of Public Utilities
Halifax, North Carolina

RSG Project No. HALIFAX-08-1

NORTH CAROLINA LICENSED SEAL 1369 GEOLOGIST JOAN A. SMYTH

Joan A. Smyth 3/18/09
Joan A. Smyth, P.G.
Principal, Senior Hydrogeologist

June 2008
Revised March 2009

RICHARDSON SMITH GARDNER
& ASSOCIATES
ENGINEERING & GEOLOGICAL
SERVICES

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1.0 INTRODUCTION

1.1 Site Background

The Halifax County Landfill (North Carolina Permit # 42-04) is located southwest of the town of Roanoke Rapids, North Carolina near Aurelian Springs. The landfill stopped accepting municipal solid waste (MSW) in December, 1997 was covered by September, 1998. The portion of the MSW landfill that is currently receiving C&D waste was closed with an interim cover, while the remaining areas were closed in accordance with 15A NCAC 13B.0500. Halifax County is currently transporting MSW to a Subtitle D landfill in Virginia and accepting construction and demolition waste into a C&D landfill (permit 42-04 CDLF-1998) located on top of the closed MSW landfill in order to bring the closed landfill area up to final closure contours. Halifax County also operates an ash monofill site (permit 42-04-indus-1994) to the north of the MSW landfill. The site map (**Figure 1**) includes the current topography and operating conditions at the landfill.

Semi-annual ground and surface water monitoring for Appendix I constituents was initiated at the Halifax County Landfill in December, 1993. Monitoring has included Appendix I detection monitoring (1993 - 1995), and Appendix II assessment monitoring (1995 - present).

Ongoing ground water monitoring at this site has indicated ground water impacts above the 2L ground water standards (15A NCAC 2L.0200 through .0202). None of the impacted wells are located more than 250 feet from the waste boundary. Four (4) wells downgradient of the site are impacted above water quality standards, while two (2) impacted wells (MW-15r and MW-16a) are located upgradient of the landfill. Given their distance from the landfill, the upgradient location of these wells, and detection of landfill gas in this area during prior investigations, landfill gas has previously been determined to be the source of impact in these wells through phase transferrence.

In 2007, an Assessment of Corrective Measures[1] was prepared to evaluate options for remediation of impacts at the site. This Corrective Action Plan is written in response to rule 15A NCAC 13B.0547 that requires a Corrective Action Plan be submitted with a Permit Application for C&D landfills accepting waste on top of closed MSW landfills. Due to the ground water impact detected upgradient and downgradient of the MSW landfill, this Corrective Action Plan is required.

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[1]Assessment of Corrective Measures - Scotland County, Richardson Smith Gardner and Associates, Inc., December, 2007.

1.2 Aquifer Characteristics

Depths to ground water generally range from near surface in lowland areas along Brewer's Creek and its tributary to up to 45 ft. below grade along the ridge east of the landfill. The potentiometric surface map for the most recent sampling event is included as **Figure 2**. The direction of ground water flow represented in this figure is consistent with previous flow patterns since 1993. Due to impact upgradient of MW-15, water levels are collected from piezometers upgradient of the landfill. All data indicate there is no ground water reversal in this area, and ground water flow is consistently to the west. **Table 1** presents well construction information, while **Table 2** presents the historical water levels measured at the site.

Ground water velocities on-site ranged from 0.011 ft/day in MW-16a to 0.330 ft/day in MW-2a during the most recent sampling event. **Table 3** presents ground water velocity calculations from the fall 2007 ground water monitoring event.

Ground water at the site is flowing generally to the west towards Brewer's Creek and its tributary. There are minor seasonal variations in the flow pattern, but the overall direction of flow is the same. It should be noted that Brewer's Creek has historically been blocked by a beaver dam downgradient of the site. This had impacted the area near MW-2a and MW-3a with slow moving water and an enlarged area of ponded water.

1.3 Contaminant Distribution

The area of ground water impact is limited to a relatively small area immediately upgradient and downgradient of the landfill. Downgradient of the landfill, wells MW-3a, MW-3d, and MW-2a, MW-2d and MW-17 indicate impact. These wells are all located within the 175 feet from the waste boundary.

Upgradient of the landfill, the area near MW-15r and MW-16a also has impacted ground water, however, this impact is primarily due to the migration of landfill gas and phase transference. Upgradient, the impact in the area adjacent to MW-15r is approximately 210 feet from the waste mass. Monitoring well MW-16a is located 140 feet from the waste mass. The ground water impacts detected during the Fall 2007 ground water monitoring event are shown on **Figure 3**.

1.4 Site Conceptual Model

Ground water at the site flows from east to west, from wells MW-15r and MW-16a upgradient of the landfill toward Brewer's Creek on the western edge of the property.

Ground water flows through unconsolidated sediments across the site to discharge in Brewer's Creek at the western edge of the site. Along the downgradient edge of the site, bedrock was encountered in MW-18d at a depth of 32 below grade.

The current ground water well network has been monitored since 1999. Analytical data from these wells indicate mildly fluctuating but overall stable levels for most constituents. In general, four constituents (benzene, tetrachloroethene, trichloroethene and vinyl chloride) are detected in downgradient monitoring wells above ground water standards, while six constituents (benzene, methylene chloride, tetrachloroethylene, trichloroethene, heptachlor and alpha BHC) are detected upgradient of the landfill. **Figure 4** shows the site hydrogeological cross-sections which include ground water impact.

It should be noted that the detections of heptachlor and Alpha BHC have not been consistent over time and have only been detected during the fall 2007 and spring 2008 events. Prior to this, Alpha BHC was last detected for a few monitoring events in 2003 and 2004.

The area of ground water impact is limited to a relatively small area immediately downgradient of the landfill near MW-3a, MW-3d, and MW-2a, MW-2d and MW-17. Upgradient of the landfill, the area near MW-15r and MW-16a also has impacted ground water, however, this impact is due to the migration of landfill gas and phase transference.

Downgradient of the landfill, the impact is limited to approximately 175 feet from the waste mass. Upgradient, constituents detected in well MW-15r are approximately 210 feet from the waste mass. Monitoring well MW-16a is located 140 feet from the waste mass.

2.0 CONTAMINANT CHARACTERIZATION

2.1 Contaminants of Concern

As stated in the Assessment of Corrective Measures[2], constituents in ground water at the site that have been detected with levels above the 2L ground water standards or the EPA Maximum Contaminant Levels (MCLs) are:

- benzene;
- methylene chloride;
- toluene;
- tetrachloroethene;

[2]Assessment of Corrective Measures - Halifax County Landfill, Richardson Smith Gardner and Associates, Inc., December 2007.

- trichloroethene;
- vinyl chloride;
- heptachlor; and
- Alpha BHC.

These detections are limited to monitoring wells MW-2ad,MW-3a, MW-6d, MW-15r, MW-16a and MW-17. These constituents are believed to be due to impact from the unlined landfill waste masses with the exception of heptachlor and Alpha BHC which are discussed below, as there is no known historical or local industry in the area that might have deposited these constituents in the ground water.

The two pesticides (alpha BHC and heptachlor) have been found in ground water from well MW-15r. These two constituents have very low vapor pressures and would not be expected to migrate via phase transferrence upgradient of the landfill as the other constituents detected in this area are. As there is no evidence of a ground water flow reversal in this area, it is likely that these constituents are due to old farm practices on this property prior to development as a landfill. It should be noted that although heptachlor was detected in the fall 2007 event, it was not detected in the spring 2008 event. Alpha BHC was detected in both these events, but had not been previously detected since 2004.

Bis (2 ethyl hexyl) phthalate was also detected above ground water standards during the most recent event. However, this constituent has not been detected consistently prior to this event and is known to usually be from issues arising from field sampling techniques. Therefore, bis (2 ethyl hexyl) phthalate is not considered to be a contaminant of concern at this time. Should future sampling events indicate this constituent is consistently present, it will be re-evaluated for inclusion as a contaminant of concern.

Several inorganic constituents have been detected at levels above ground water standards. However, due to the age of the wells and the turbidity noted during sampling, we believe these detections are more likely due to suspended solids in the samples.

2.2 Contaminant Source Confirmation

Contaminants detected in the monitoring wells surrounding the closed Halifax County MSW landfill are due to impact from the unlined landfill with the exception of heptachlor, alpha BHC and bis (2 ehtyl hexyl) phthalate. Other sources for these constituents (past farming practices on the site and sample contact with gloves) are discussed above.

2.3 Source Control Measures

Three corrective actions have previously been put into action at the site. These are:

- Installation of a LFG collection trench in the area of MW-15r.
- Closure of the unlined landfill in 1998
- Ongoing placement of C&D waste on top of the landfill to create final contours that will drain water more efficiently and minimize the infiltration of water into the waste mass in the long term.

The closure of the landfill consisted of a compacted soil cover on the sideslopes and an interim compacted soil cover over the area where C&D is currently being interred. Once closure contours are achieved with C&D waste, this area will receive final closure.

2.4 Ground Water End Use

RSG personnel have evaluated the surrounding areas for potential receptors that could be impacted by contaminated ground water. A potable well survey identified 24 potable water wells within 2000 feet of the site boundary. None of the area water wells are considered to be downgradient of the closed MSW landfill. The potable well users are shown on **Figure 5**.

Significant ground water users within two miles of the site include two schools: a high school located approximately 1.5 miles northeast of the site, and an elementary school located approximately 0.8 miles south of the facility boundary. Neither ground water user facility is downgradient of the site.

There are no public water supply wells in the vicinity of the site. No surface water intakes or residential subdivisions are known to exist within two miles of the site. The nearest known public water service is Roanoke Rapids. Municipal water is available in the vicinity. Municipal water is purchased from the Roanoke Rapids Sanitary District and is resold by the County. The source of the municipal water supplied in this area is the Roanoke River.

2.5 Sensitive Receptor and Exposure Pathways/Risks

The primary sensitive receptors and exposure pathways are the residential potable wells. Secondary sensitive receptors include Brewers Creek downgradient. The exposure pathways for the potable wells include ingestion and through skin contact. The exposure pathway for the surface water is primarily through skin contact (as this surface water body is not a source of drinking water). Semi-annual surface water monitoring has indicated no impact from the landfill. Detailed evaluation of exposure pathways and risks was performed as a part of the Assessment of Corrective Measures previously referenced.

2.6 Background Concentrations

Monitoring well MW-1 is the current background ground water monitoring well for the site. This well is located upgradient of the ash monofill site and continually indicates no detectable concentrations for assessment monitoring constituents.

2.7 Exceedances of Ground Water Quality Standards

A total of seven (7) constituents have been detected at levels above the ground water protection standards:

- benzene;
- methylene chloride ;
- tetrachlorethene;
- trichloroethene ;
- toluene;
- vinyl chloride;
- heptachlor; and
- Alpha BHC.

All ground water impact is detected within 250 feet of the landfill.

The low levels of other chlorinated solvents (cis 1,2 dichloroethene, 1,1 dichloroethane) in conjunction with the detected vinyl chloride could be indicative of reductive dechlorination ongoing in the downgradient portion of the site. Reductive dechlorination is a naturally occurring process whereby anaerobic bacteria degrade chlorinated hydrocarbons. In samples from MW-3a, levels of cis-1,2 dichloroethane appear to be decreasing over time. This could indicate microbial dechlorination and natural attenuation already occurring at the site. The relative stability of the plume and lack of downgradient migration further support the idea that natural attenuation is occurring at the site.

2.8 Exceedances of Surface Water Quality Standards

There have been no exceedances of surface water quality standards at this site.

2.9 Media of Concern

Soils at the site are not considered to be an exposure medium since the impact to soils is likely to be limited to soils immediately below the landfill footprint. As stated above, LFG migrating from the waste mass is not found in sufficient quantities near off-site receptors (the property line) to merit consideration of soils as a medium of exposure.

Historical surface water data indicate that surface water at this site has not been impacted by the unlined MSW landfill. Therefore, surface water is not considered an exposure medium for this site.

The presence of landfill gas detected upgradient of the landfill, and ground water impacts in this area indicate that landfill gas is present in this area of the site and is likely impacting ground water through phase transference. Therefore, landfill gas is a concern in the upgradient portion of the site. It should be noted that landfill gas is not detected near the property line and is therefore only considered a concern due to phase transference (migration of contaminants from landfill gas to ground water by condensation) that appear to be occurring.

Historical monitoring at the site indicate that only ground water is impacted above ground water protection standards. Ground water is the main media of concern at the site.

3.0 SELECTED AND APPROVED REMEDY/TECHNICAL APPROACH

The Halifax County Landfill will utilize two remedial actions at this site: Monitored Natural Attenuation (MNA) for the downgradient portion of the site, and Active Landfill Gas Recovery in the upgradient area of the site. These are discussed in detail below.

3.1 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) consists of monitoring the natural attenuation processes. This is a proven remedial technology and is appropriate for sites that do not pose a substantial or immediate risk to the environment or human health. MNA allows both physical and biological processes that naturally occur (including dilution, adsorption, volatilization, dispersion and biological degradation of contaminants) to manage the impact to ground water.

MNA requires that ground water at the site be monitored at regular intervals to monitor the progress of the degradation process by various indicators. This regular monitoring is also designed to ensure that the dissolved phase plume is not migrating toward a sensitive receptor

At landfill sites, MNA includes the action of naturally occurring anaerobic bacteria which degrade chlorinated hydrocarbons in a process called reductive dechlorination. Reductive dechlorination can stabilize and even decrease the size of plumes. As stated earlier, there is evidence that this process is already occurring at the Halifax County landfill.

MNA remedial strategy requires the monitoring of several processes/indicators that aid in the evaluation of changing plume geometry (whether the plume is stable, expanding or shrinking). Primary evidence for natural attenuation is a stable or shrinking plume at a site, such as we have observed at the Halifax County Landfill.

3.1.1 Monitored Natural Attenuation - Technical Approach

The monitoring frequency for MNA varies by site conditions such as water table fluctuations, ground water velocity, seasonal variability and plume migration. Due to the stability of the plume geometry, and the stability of the general aquifer conditions at the site, two years of semi-annual monitoring for MNA indicators and Appendix I plus detected Appendix II parameters will be sufficient to establish a baseline trends for continued MNA evaluations over time. MNA indicator parameters that will be analyzed during the baseline process include:

- Dissolved Oxygen;
- Nitrate;
- Iron;
- Sulfate;
- Sulfide;
- Methane;
- Ethene, Ethane;
- ORP;
- TOC/BOD/COD;
- CO_2;
- Alkalinity;
- Chloride;
- Hydrogen;
- Volatile Fatty Acids;
- pH;
- Temperature;
- Conductivity; and
- Turbidity.

Due to spatial constraints at the landfill, all downgradient impacted monitoring wells will be utilized as performance wells for the MNA evaluations. Monitoring wells MW-18s, MW-18d, G13 and G-13d will be utilized as sentinel wells. Furthermore, surface water samples will be utilized as sentinel points as well due to the low levels of impact detected near Brewer's Creek.

3.2 Landfill Gas Recovery

Currently, there is a passive vent landfill gas vent trench located between the landfill and monitoring well MW-15r. This trench is approximately 350 feet long and is constructed to a maximum depth of 15 feet below grade. The trench is backfilled with stone and a header pipe which is attached to each of the four (4) passive vents. The chosen remedial strategy for this portion of the landfill is active landfill gas recovery through Blower Assisted Solar Flares (BASF) (or equivalent) attached to existing vents in the passive vent trench.

3.2.1 Landfill Gas Recovery- Technical Approach

Prior to system construction, gas generation calculations will be performed to determine the amount of landfill gas expected to be collected by the existing trench. At this time, it is believed that two BASF Units (or equivalent) will be utilized on two of the existing vents for the active recovery system. BASF Units will provide a vacuum of approximately 50 cfm and combustion of landfill gas recovered. The remaining two passive gas vents will be capped in order to maximize recovery by the BASF Units from the trench. Information on the BASF Units is included in **Appendix C**. Prior to construction of this system, a permit from the Division of Air Quality may be required. If so, permitting will be necessary prior to system construction which may impact scheduling addressed in **Section 7.0**.

4.0 GROUND WATER AND SURFACE WATER MONITORING

4.1 Water Quality Monitoring Plan

A revised Water Quality Monitoring Plan to incorporate MNA at this site is included in **Appendix B**. This plan outlines all procedures for collection and evaluation of ground water and surface water samples at the site.

5.0 EVALUATION OF EFFECTIVENESS AND REPORT SUBMITTALS

5.1 Monitored Natural Attenuation

There are two key factors in the evaluation of the effectiveness of MNA:

1) confirmation that the contaminant plume is behaving as predicted (stabilized); and

2) evaluation of geochemical data to evaluate the component of natural attenuation. To evaluate these two factors, RSG will prepare the following for submittal as part of the regular semi-annual reporting:

- Maps of contaminant concentrations;
- Graphs of contaminant concentrations over time;
- Mann-Kendall statistical analysis of concentration trend;
- Field measurements of dissolved oxygen, redox potential, pH, temperature, conductivity, and turbidity;
- Laboratory analysis of MNA indicator parameters;
- An evaluation of surface water quality at the site; and
- An approved MNA screening model will be performed and submitted with each semi-annual event during the two-year baseline period.

After the completion of the baseline sampling events, the MNA performance parameters will be reevaluated to determine if the sampling frequency may decrease for specific MNA performance parameters of if some parameters may be removed from the corrective action sampling program based upon technical evaluation. Any proposed changes to the MNA sampling program will be submitted to NCDENR for review and approval prior to implementation.

MNA effectiveness will be judged based upon the reduction of contaminant concentrations, the stability of the impacted ground water plume, and on statistical evaluations of decreasing contaminant trends along specific flow paths.

5.1.1 MNA Contingency Triggers

The following triggers will be utilized to determine when contingency measures regarding MNA should be put into place:

- Upon completion of baseline MNA monitoring, contaminants are detected above surface water standards in the downgradient surface water sample for four consecutive monitoring events; and

- Upon completion of baseline MNA monitoring, contaminant concentrations in downgradient wells exhibit statistically increasing trends or concentrations above the ground water standards for four consecutive monitoring events.

5.2 Landfill Gas Recovery

The primary role of the landfill gas recovery at this site is to improve ground water quality upgradient of the site. The following evaluations will be made on a quarterly basis (unless otherwise specified) to determine the effectiveness of the active landfill gas recovery system:

- Measurements of LFG levels at the flares;
- Observations of flare operation on a weekly basis; and
- Semi-annual statistical evaluation of trends in ground water contaminant levels in the upgradient landfills.

5.2.1 Landfill Gas Recovery Contingency Triggers

The following triggers will be utilized to determine when contingency measures regarding the landfill gas recovery system should be put into place:

- Statistical analysis indicates increasing trends of contaminants in the upgradient wells two years after active landfill gas recovery begins;
- Measurements of LFG levels at the flares indicate less than 20% LFG during three consecutive readings (the BASF Units typically require >25% LFG to operate).

6.0 CONTINGENCY PLAN

As stated above ground water monitoring data from the site will be closely evaluated to determine whether MNA is occurring at the site and whether active landfill gas recovery is improving ground water quality upgradient of the landfill. Should the contingency plan be triggered downgradient of the site, the following measures will be taken:

- Evaluation of alternate remedial strategies, including, but not limited to, phytoremediation or enhanced bioremediation;
- Pilot studies of one or more alternate remedial strategies.

Should the contingency plan be triggered upgradient of the site, the following measures will be taken:

- Evaluation of landfill gas generation rates;
- Evaluation of landfill gas levels adjacent to the upgradient monitoring wells through the installation of gas probes in these areas;
- Evaluation of more aggressive landfill gas recovery options if landfill gas levels and pressures warrant; and
- Evaluation of other remedial strategies (such as enhanced bioremediation) if landfill gas levels and pressures in the area indicate that phase transference is not the method of impact to ground water in this area.

7.0 SCHEDULE AND MAINTENANCE

7.1 MNA Schedule

The MNA baseline monitoring will begin with the next semi-annual ground water monitoring event that occurs after final approval of this plan. Baseline sampling will be performed for a period of two years on a semi-annual basis. Once the baseline Is completed the MNA performance parameter data will be evaluated for any changes. Any proposed changes will be submitted to NCDENR for approval prior to implementation.

An EPA approved MNA screening model will be prepared semi-annually during the baseline sampling period and annually thereafter to simulate ground water remediation at the site. Every 5 years an MNA Corrective Action Evaluation Report will be prepared that evaluates all MNA data during the preceding 5 years and reviews MNA performance.

7.2 Landfill Gas Recovery Schedule

Initial evaluations of landfill gas generation rates and measurements in this area will be performed within three months of final approval of this document. Once the evaluations are complete, the installation of BASF Units (or equivalent) will take place. We expect the landfill gas recovery system will be installed within six (6) months of the final approval of this plan.

8.0 FINANCIAL ASSURANCE REQUIREMENTS

A Financial Assurance Evaluation is included in **Attachment I** of the C&D Permit Application. This evaluation includes funds for the corrective measures proposed in this document.

Remedial Costs

MNA and LFG Recovery Design Costs	$8,000.00
Installation of two BASF Units on Existing LFG Trench	$15,000.00
MNA Sampling and Analysis (not including normal detection/assessment monitoring costs for 8 wells semi-annually, and 2 monitoring wells annually in accordance with WQMP[3] - cost of $833.33 per well)	$15,000/year
Evaluation and Reporting	$5,500.00/year
Subtotal	$43,500.00
Contingency (10%)	$4,350.00
Total (first year)	**$47,850.00**
30-Year Total	**$615,000.00**

9.0 COMPLETION OF CORRECTIVE ACTION

These remedial strategies shall remain in place until remedial goals have been met. In this case, the remedial goals are contaminant levels that do not exceed the 2L ground water standards, or, if no 2L standard exists, EPA MCLs. If these remedial strategies prove to be inadequate, alternative remedial strategies should be developed. At that time, alternative corrective action goals may be set (with the approval of NCDENR).

[3]Water Quality Monitoring Plan Scotland County Landfill, Richardson Smith Gardner and Associates, Inc., November 2008